



Original Research

Effect of isometric quadriceps in reduce pain in patients of knee osteoarthritis

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Abstract

Osteoarthritis (OA) is a degenerative disease that often occurs, both in Indonesia and abroad. OA is characterized by progressive destruction of joint cartilage and causes structural changes in the joints. OA disease from grades 1 to 4 has symptoms that are usually difficult for the sufferer's life. One of these symptoms is joint pain, but reducing pain intensity, especially OA grades 1 to 3, it can be done with exercise. The use of this exercise is an isometric quadriceps exercise. The design of this study used a quasi-experimental design with a pre-post test control group design with a sample of 40 respondents who met the inclusion and exclusion criteria, namely patients with knee osteoarthritis, stage II, and III who underwent the initial rehabilitation program. Based on the results of data processing using the Wilcoxon test in the control group, the p -value = $0.01 < 0.05$, while in the intervention group the p -value = $0.00 < 0.05$. From these results, it can be concluded that isometric quadricep exercise is effective in reducing pain intensity in osteoarthritis genu grades 1 to 3. So isometric quadricep exercise can be recommended as an independent therapy in reducing knee osteoarthritis pain intensity.

INTRODUCTION

Based on data from the World Health Organization (WHO) in 2016, osteoarthritis is the most common musculoskeletal disease, with a prevalence of knee osteoarthritis reaching 3.8% and hip by 0.85% globally (WHO, 2016). Meanwhile in Indonesia, based on the results of the 2018 Riskesdas, it shows that the prevalence of the joint disease is around 7.3% and osteoarthritis is the most common joint disease. This disease is commonly associated with increasing age, or what is known as a degenerative disease.

In the 15-24 year age range, the prevalence rate is only around 1.3%, in the 24-35 year age range it is around 3.1%, and the prevalence has doubled in the 35-44 year age range which is 6.3%.¹

Osteoarthritis (OA) comes from the Greek words osteon meaning bone, arthro meaning joint, and itis meaning inflammation. Osteoarthritis is a joint disorder characterized by progressive degeneration of articular cartilage, resulting in loss of joint space and the appearance of new bone.²

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Osteoarthritis is most common, especially in the adult and elderly age groups. Almost all people over the age of 70 experience symptoms of osteoarthritis, with varying degrees of pain. Before the age of 55 years, the ratio of osteoarthritis in men and women is comparable, but at the age of over 55 years, it is more in women. Old age is the last period in the human life span. Old age is marked by several changes, both physically, psychologically, and socially, where these changes will affect the physical and mental conditions of the elderly. Old age is a risk factor for osteoarthritis. Other risk factors include a family history of osteoarthritis, being overweight, work that requires squatting or kneeling for more than 1 hour per day. Lifting goods, climbing stairs, or walking long distances are also risks.³

Osteoarthritis has symptoms that are usually difficult for the sufferer's life. These symptoms include recurrent pain or tenderness in the joints, stiffness, limited range of motion, crackling sounds (crepitus), swelling in the joints (swelling in a joint), quadriceps muscle weakness, and muscle atrophy around the knee joint, knee joint instability.⁴ Pain is the biggest main symptom in joints that experience osteoarthritis. Pain is caused after doing activities with the use of joints and pain can be alleviated.⁵ Patients with osteoarthritis pain will experience joint and muscle dysfunction so they will experience limited movement, decreased strength, and muscle balance. Approximately 18% experience difficulties and limitations in activities, loss of function, work capacity, and decreased quality of life.⁶

Analgesic is the main therapy in pain management. Unfortunately, one of the biggest reasons for inappropriate pain management is the lack of knowledge about analgesic pharmacology. Although pain management is through the use of drugs, several non-pharmacological techniques can also help control pain such as massage, exercise, relaxation and

imagination, nerve stimulation with transcutaneous electricity, use of hot and cold compresses, therapeutic touch, meditation, hypnosis, acupressure, and TENS (Transcutaneous Electrical Nerve Stimulation). These techniques are generally safe, readily available, and can be performed at home or in a care setting.⁷

Exercise is recommended for the elderly with osteoarthritis with grades 1 to 3 to strengthen muscle and joint mobility, improve functional capacity, relieve pain and stiffness, and prevent further deformity. Therefore, the management of the pain system should be a new target for both pharmacological and non-pharmacological interventions.⁸ Physical exercise therapy can provide benefits to patients both directly and indirectly. Isometric quadriceps exercise is another form of elastic resistance that allows people to perform different exercises to increase strength, mobility, function, and reduce joint pain.⁹

Isometric quadriceps exercise is an exercise by contracting the muscles that are carried out to see changes in increasing muscle strength. This is due to changes in muscle morphology, namely the greater the muscle mass formed, the more mitochondria will be produced. The effect of strengthening exercises will increase the dynamic strength of the muscles so that muscle power increases. When muscle power increases, endurance and balance will also increase. Blood circulation will increase due to vasodilation of blood vessels. In addition, it will also improve strength, size and prevent inflammation and increase the flexibility of fat tissue which can reduce pain.¹⁰

The American College of Rheumatology explains that strengthening the femoral quadriceps muscle in patients with osteoarthritis of the knee can increase muscle strength, reduce joint pain, and reduce joint stiffness. In addition to this, muscle strengthening is also a step that can

speed up time to perform important activities in daily life such as the ability to walk. Muscle strengthening is an effective therapy in reducing pain and increasing functional ability in patients with mild to moderate knee osteoarthritis.¹¹⁻¹³

Kendal 1 Health Center is one of the health centers in the Kendal area with quite a lot of osteoarthritis patients with the number of osteoarthritis patients in the last 3 months in March 2021 was 43 patients. Based on observations and interviews from 4 patients in the outpatient clinic and orthopedic rehabilitation room in patients diagnosed with knee osteoarthritis grade K/L II, all patients underwent a physical examination and then were given pharmacological therapy in the form of analgesic drugs and supplements. From this preliminary study, the authors assessed the need to apply isometric quadriceps exercise therapy as a strengthening of the quadriceps muscle because based on the results of the latest research by.¹³ it has proven to be very effective in helping reduce pain intensity.

METHODS

This study uses a quasi-experimental research design or quasi-experimental research. The research design used a pre-post test control group design, which was done by giving a pre-test before the treatment was given and a post-test was taken after the treatment was given, the intervention group was given analgesics and isometric quadriceps while the control group was given primary therapy, namely analgesics. . Sampling in this study by probability sampling using a random sampling technique. The population in the study were all patients with knee osteoarthritis in the Kendal 1 Public Health Center with the criteria of the patient being >50 years old, moderate pain 4-7, knee flexion angle > 90o, and patients with a medical diagnosis of OA grade II or III (K/L scale). . The sample used in this study was 40 respondents consisting of an

experimental group of 20 respondents and a control group of 20 respondents, this study was conducted on 2 July – 26 November 2021. Univariate and bivariate analysis data using the Wilcoxon test.

The flow of this intervention is to select patients according to inclusion and exclusion criteria, explain the purpose and benefits of the procedure, ask for consent and sign informed consent, measure the initial pain scale before exercising, warm up by walking around the place that has been provided for 10 minutes, then sitting with a 90o tutu flexion angle while straightening the OA genu leg for 10 seconds and measuring the pain scale after the procedure, and evaluating on the 36th day of the intervention. Collecting data in this intervention by measuring and interviewing respondents related to name, age, gender, Body Mass Index (BMI), and occupation, while data assessing pain intensity before and after therapy using the Numeric Rating Scale (NRS) instrument.

RESULTS

The results of the univariate analysis provide an overview of the distribution of participants according to participant characteristics (Gender, Age, and Body Mass Index) and the evaluation results in the provision of isometric quadriceps exercise (pain scale).

Gender Characteristics

Table 1
Distribution of Characteristics by Gender
Intervention (N=20) and Control (N=20) groups

Indicators	f	%
Jeni Gender of Control group		
Man	3	15
Woman	17	85
Gender of Intervention group		
Man	4	20
Woman	16	80

Based on table 1 above, it can be concluded that the frequency of gender in the control

group is mostly female, with as many as 17 (85%) respondents with knee osteoarthritis. While the frequency of gender in the intervention group was mostly female, as many as 16 (80%) respondents.

Characteristics of Age and Body Mass Index

Table 2
Distribution of Characteristics of Participants by Age, and Body Mass Index (N=40)

Indicators	Group	
	Intervention	Control
Age	61,55+1,317	61,70+1,525
Body mass Index	30,30±1,630	30,25±1,616

Based on table 2 shows the average age of the control group respondents in this study was 61.7 years with a standard deviation of +1.525. Then from the interval estimation results, it is known that 95% of respondents have an age range of 60.99 years to 62.41 years. Meanwhile, the intervention group was 61.55 years old with SD: +1.317. Then from the interval estimation results, it is known that 95% of respondents have an age range of 60.93 years to 62.17 years. Then for the BMI of respondents in the control group, the average BMI is 30.25 with SD: +1.616. Then it can be seen from the results of the interval estimation that 95% of the participants are in the range of BMI 29.49 to 31.01. Meanwhile, the intervention group has a mean BMI of 30.30 with SD: +1.630. Then it can be seen from the results of the interval estimation that 95% of participants are in the BMI range of 29.54 to 31.06.

Results of Isometric Quadriceps Exercise Before and After Intervention in the Intervention and Control Group

Based on the results of table 3 in the control group, it can be concluded that the average pain scale before and after being given primary intervention the first week to

week 12 is 5.00 with an SD value: 2.693 and p-value: 0.01. While the average pain scale intervention group before and after the isometric quadriceps exercise in weeks 1 to 12 was 5.00 with an SD value: of 9.811 and p-value: 0.00.

Table 3
The effect of quadriceps exercise in reducing pain in the control group (N=20)

Indicators	Group	
	Intervention	Control
Pain level before intervention	5,25+0,444	5,5+0,513
Pain level after intervention	0,90+0,308	4,75+0,716
p	0,000*	0,010*

* Wilcoxon test

DISCUSSION

In the provision of isometric quadriceps exercise therapy for 12 weeks where every week for 3 days (Monday, Wednesday, and Friday) and 3 times a day (morning, afternoon, and evening) with each period of 10 minutes 10 seconds. In carrying out the implementation, respondents are required to warm up first for 10 minutes by walking around the exercise area. Immediately discontinued if knee pain appears with a pain scale (> 6) or other responses that worsen the respondent's condition. Second, participants were asked to sit in a chair by bending their knees at an angle of 90°, then straightening their legs fully for 10 seconds.

Characteristics of Respondents

The results of the primary intervention and the application of quadriceps exercise with isometric quadriceps exercise in the control and intervention groups showed that most of them had an average age of 60-65 years. In this age range, participants experienced knee joint disorders in the form of osteoarthritis. A study links the aging process with disorders of knee joint osteoarthritis. Aging is associated with susceptibility to chronic diseases, including knee joint disorders such as osteoarthritis

and osteoporosis.^{14,15} Osteoarthritis can occur during menopause, namely the age of 45-49 years¹⁶, then 59% occur at the age of 55-74 years and 31% occur over the age of 75 years.¹⁷

The aging process is a normal thing. Aging results in a progressive loss of physiological integrity, resulting in impaired function and decreased adaptive capacity to stress. In addition, aging also increases exposure to the environment.¹⁸ Older age is also associated with the development of osteoarthritis due to biological changes such as decreased synovial fluid secretion over time.¹⁹ Then increasing age is associated with cellular aging which plays a role in cell inflammation in the incidence of osteoarthritis.¹²

Most of the respondents in the control group were women, as many as 17 people (85%) while in the intervention group there were 16 people (80%). This is the same as the other study showed that where most of the knee osteoarthritis participants were 57 women (89.06%) and 7 men (10.94%).¹⁹ This is also following the incidence of osteoarthritis in the other study that many as 685.9 per 1,000 for women and 324.1 per 1,000 for men.⁵ Then the incidence of osteoarthritis increases the surgical program of joint replacement, either Total Knee Replacement (TKR) or Total Hip Replacement (THR) more in women over the age of 50 years and men over the age of 60 years. This is also stated by other research that women suffer from knee osteoarthritis more than men.²⁰ Women have twice the risk of knee injury and osteoarthritis because women's hips are wide, this causes the knees of the legs to be wider and "O" shaped so that the joint position is uneven, as well as less muscle mass around the knees of women than men. In addition, there are other factors, namely, the menopause process in women is faster than in men which has an impact on the decrease in the hormone estrogen

where the function of this hormone is to give an effect of elasticity to the joints.

Respondents in the control group had a Body Mass Index (BMI) above normal, which had a mean BMI of 30.25 with a standard deviation of +1, 616, while the intervention group had a mean of 30.30 with an SD of +1, 630. will have a high effect or impact on the occurrence of osteoarthritis. The results of this study are supported by other research who states that both male and female sexes have the opportunity to have an excessive BMI, because men experience visceral (abdominal) obesity while women can contribute to increased fat which is supported by modern times, namely a bad lifestyle that can affect the increase in BMI.²¹

Effect of Isometric Quadriceps Exercise on Knee Osteoarthritis Pain Intensity

The results of the primary intervention on 20 respondents in the control group showed an effect with a P-value of 0.010. While the results of the isometric quadriceps exercise in the intervention group showed a significant effect with a p-value of 0.000. This shows that the application of isometric quadriceps exercise for 12 weeks is effective in reducing pain intensity in patients with knee osteoarthritis. This is following several previous studies that the application of isometric quadriceps exercise for 2 months is effective in reducing the intensity of knee osteoarthritis pain with a p-value = 0.001.^{9,22} Likewise, research on the effect of quadriceps exercise on pain intensity in knee osteoarthritis patients for 2 weeks decreased significantly (p = 0.002, 0.05) and was more effective in increasing daily activities.¹³

The existence of quadriceps muscle exercise is effective in reducing the intensity of knee osteoarthritis pain with a p-value of 0.000. These muscle

strengthening exercises can be done as a patient's routine and alternative therapy in reducing the pain intensity of grade I, II, III (K/L) knee osteoarthritis from mild to moderate pain. This is in line with research conducted by other research who said that isometric quadriceps exercise was very significant ($p = 0.001$) in reducing knee osteoarthritis pain and improving joint elasticity.²³ Wherewith the exercise of the hamstring and quadriceps muscles it will reduce other problems such as impaired muscle flexibility, joint stability, muscle wasting which further worsens the condition and increases pain.

Because no cure has been found for osteoarthritis except surgery, its management focuses on how to reduce symptoms such as relieving pain, increasing joint tasks is the main goal in providing nursing care.⁴ Osteoarthritis also causes a decrease in knee joint stability due to impaired quadriceps muscle strength, pain, and altered joint structure.²⁴ To maintain joint function and reduce knee instability, the hamstring muscles must be activated so that compensation occurs. Thus, nursing actions are often recommended to reduce pain and increase mobility. So exercise movements must be done regularly to prevent muscle atrophy. A regular and measured exercise program is recommended for osteoarthritis patients. Type of exercise therapy with a focus on muscle strengthening and stretching exercises (flexibility). Several muscle groups that function to control the movement and stability of the knee are the quadriceps muscles in the front and the Hamstrings muscles in the back.²⁵

CONCLUSION

The characteristics in this study that can affect the occurrence of the osteoarthritis process are gender, age, and BMI. The isometric quadriceps exercise is effective in reducing pain intensity in patients with knee osteoarthritis grades I, II, and III from

mild to moderate pain. With this exercise, there is an increase in the synthesis of proteoglycans which will increase the formation of the bone matrix and attract cations so that there is an increase in osmolality in the joint cartilage. This makes the joint surface slippery and the joint easy to move so that pain is reduced. In addition, the exercise can also improve the daily activities that become the routine of the participants. During the implementation of the isometric quadriceps exercise, there were no adverse side effects on the participants, but it was proven effective in reducing pain and drastically increasing the participants' daily activities.

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REFERENCES

1. Kemenkes RI. Laporan_Nasional_RKD2018_FINAL.pdf. Badan Penelitian dan Pengembangan Kesehatan. 2018. p. 198.
2. Neelapala YVR. Influence of isometric exercise on pressure pain sensitivity in knee osteoarthritis - ProQuest. 2018. p. 361-7.
3. Ragni E, Papait A, Perucca Orfei C, Silini AR, Colombini A, Viganò M, et al. Amniotic membrane-mesenchymal stromal cells secreted factors and extracellular vesicle-miRNAs: Anti-inflammatory and regenerative features for musculoskeletal tissues. *Stem Cells Transl Med.* 2021;
4. Khairurizal K. Perbandingan Pengaruh Kombinasi Latihan Hold Relax Dan Open Kinetic Chain Dengan Latihan Hold Relax Dan Close Kinetic Chain Terhadap Peningkatan Kemampuan Fungsional Pasien Osteoarthritis Knee. *Nusant Med Sci J.* 2019;4:55.
5. Madry H, Kon E, Condello V, Peretti GM, Steinwachs M, Seil R, et al. Early osteoarthritis of the knee. Vol. 24, *Knee Surgery, Sports Traumatology, Arthroscopy.* Springer Verlag; 2016. p. 1753-62.
6. Pamungkas YI, Hartati E, Supriyono M, Jurusan D, Universitas K, Semarang D, et al. Efektifitas Pemberian Stretching Terhadap Di Unit

- Pelayanan Sosial Lanjut Usia. *J Ilmu Keperawatan dan Kebidanan*. 2017;1-9.
7. Vance CGT, Rakel BA, Blodgett NP, Desantana JM, Amendola A, Zimmerman MB, et al. Effects of transcutaneous electrical nerve stimulation on pain, pain sensitivity, and function in people with knee osteoarthritis: A randomized controlled trial. *Phys Ther*. 2012;92:898-910.
 8. Hasanah K. Pengaruh Terapi Transcutaneous Electrical Nerve Stimulation Dan Kompres Panas Dalam Menurunkan Nyeri Pada Penderita Osteoarthritis Lutut. 2014;
 9. Arif A, Siddique MA, Shahid G, Khan R, Usman M. International Journal of Physical Medicine and Effect of Resistance Training of Quadriceps Muscle in Patients with Knee Osteoarthritis : A Randomized Control Trial. 2020;8:3-6.
 10. Sriwijaya JK, Titin T, Akademi M, Panti K, Yogyakarta R. Artikel Penelitian Efektivitas Latihan Lutut Terhadap Penurunan Intensitas Nyeri Pasien Osteoarthritis Lutut Di Yogyakarta. Vol. 2. 2015.
 11. Erviandani BW, Ridwan M, Agustin D. Pengaruh Penguatan Otot Quadriceps Femoris terhadap Kemampuan Naik Tangga pada Pasien Osteoarthritis Genu di RSUD dr. Saiful Anwar Malang. Vol. 3, *Majalah Kesehatan FKUB*. 2016 Nov.
 12. Wang J, Xie Y, Wang L, Lei L, Liao P, Wang SQ, et al. Hip abductor strength-based exercise therapy in treating women with moderate-to-severe knee osteoarthritis: a randomized controlled trial. *Clin Rehabil*. 2020;34:160-9.
 13. Yuenyongviwat V, Duangmanee S, Iamthanaporn K, Tuntarattanapong P, Hongnaparak T. Effect of hip abductor strengthening exercises in knee osteoarthritis: a randomized controlled trial. 2020;
 14. Charlesworth J, Fitzpatrick J, Perera NKP, Orchard J. Osteoarthritis- a systematic review of long-term safety implications for osteoarthritis of the knee. *BMC Musculoskelet Disord*. 2019;20:1-12.
 15. Rausch Osthoff AK, Juhl CB, Knittle K, Dagfinrud H, Hurkmans E, Braun J, et al. Effects of exercise and physical activity promotion: Meta-analysis informing the 2018 EULAR recommendations for physical activity in people with rheumatoid arthritis, spondyloarthritis and hip/knee osteoarthritis. *RMD Open*. 2018;4:713.
 16. Lou C, Xiang G, Weng Q, Chen Z, Chen D, Wang Q, et al. Menopause is associated with articular cartilage degeneration: A clinical study of knee joint in 860 women. *Menopause*. 2016;23:1239-46.
 17. Jung JH, Bang CH, Song GG, Kim C, Kim JH, Choi SJ. Knee osteoarthritis and menopausal hormone therapy in postmenopausal women: A nationwide cross-sectional study. *Menopause*. 2019;26:598-602.
 18. Newberry SJ, FitzGerald J SN. Treatment of Osteoarthritis of the Knee: An Update Review. *Comp Eff Rev*. 2017;1-1196.
 19. Hussain SM, Cicuttini FM, Alyousef B, Wang Y. Female hormonal factors and osteoarthritis of the knee, hip and hand: a narrative review. Vol. 21, *Climacteric*. Taylor and Francis Ltd; 2018. p. 132-9.
 20. Ibrahim SA, Blum M, Lee GC, Mooar P, Medvedeva E, Collier A, et al. Effect of a decision aid on access to total knee replacement for black patients with osteoarthritis of the knee a randomized clinical trial. *JAMA Surg*. 2017;152:164225.
 21. Mutiwaru E, Najirman N, Afriwardi A. Hubungan Indeks Massa Tubuh dengan Derajat Kerusakan Sendi pada Pasien Osteoarthritis Lutut di RSUP Dr. M. Djamil Padang. *J Kesehat Andalas*. 2016;5.
 22. Wang D, Wang Y, Madhu S, Liang H, Bray CL. Total hemoglobin count has significant impact on A1C — Data from National Health and Nutrition Examination Survey 1999-2014. *Prim Care Diabetes*. 2019;13:316-23.
 23. Brosseau L, Taki J, Desjardins B, Thevenot O, Fransen M, Wells GA, et al. The Ottawa panel clinical practice guidelines for the management of knee osteoarthritis. Part two: Strengthening exercise programs. *Clin Rehabil*. 2017;31:596-611.
 24. Sharma S, Mishra AJ. Diabetes self-care management: Experiences of the socio-economically backward sections of Jammu. *Diabetes Metab Syndr Clin Res Rev*. 2019;13:1281-6.
 25. Hatfield GL, Costello KE, Astephen Wilson JL, Stanish WD, Hubley-Kozey CL. Baseline Gait Muscle Activation Patterns Differ for Osteoarthritis Patients Who Undergo Total Knee Arthroplasty Five to Eight Years Later From Those Who Do Not. *Arthritis Care Res*. 2021;73:549-58.